

Virginia
WiNS
Wireless Network Services with LMDS



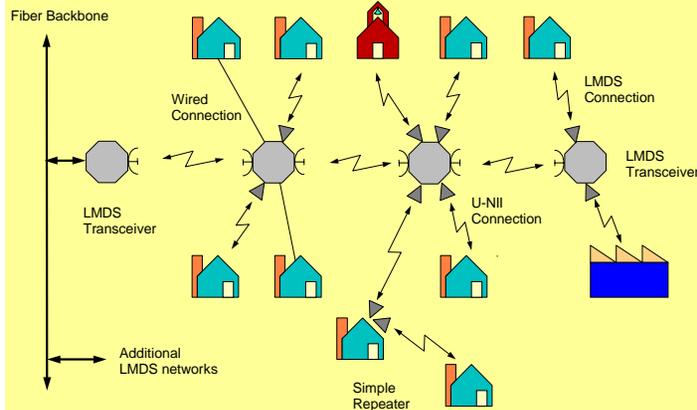
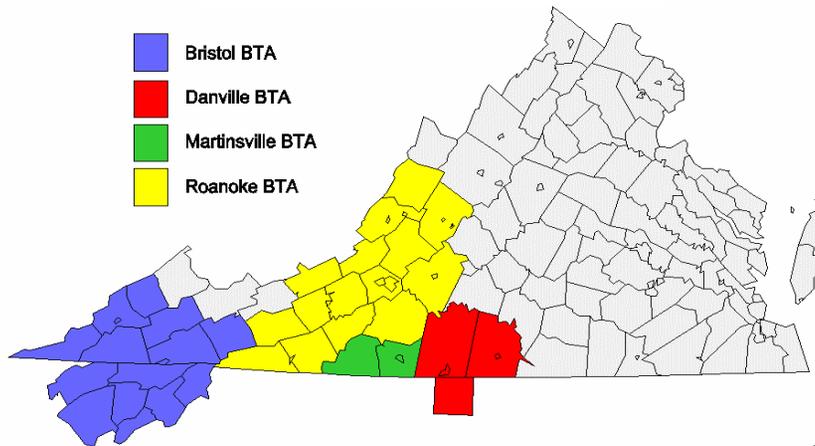
Neighborhood LMDS or The Microwave Neighborhood

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The Center for Wireless
Telecommunications

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Outline

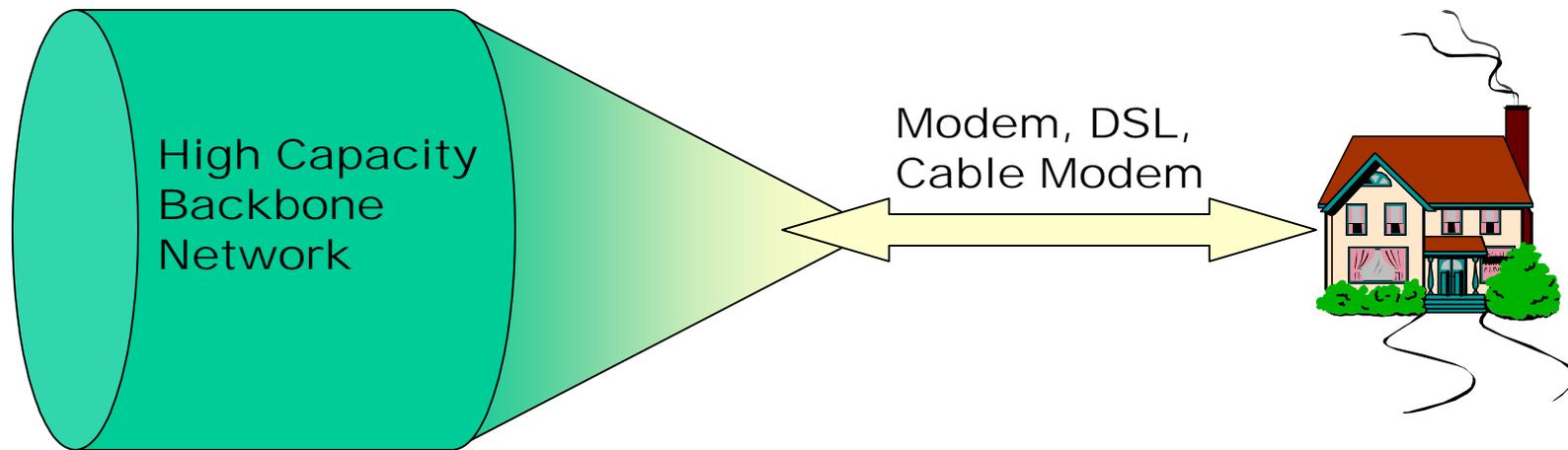
**Broadband Wireless Services: Promises
and Problems**

**The “Microwave Neighborhood”
Architecture**

Low-Cost LMDS Transceivers

Deployment Plans

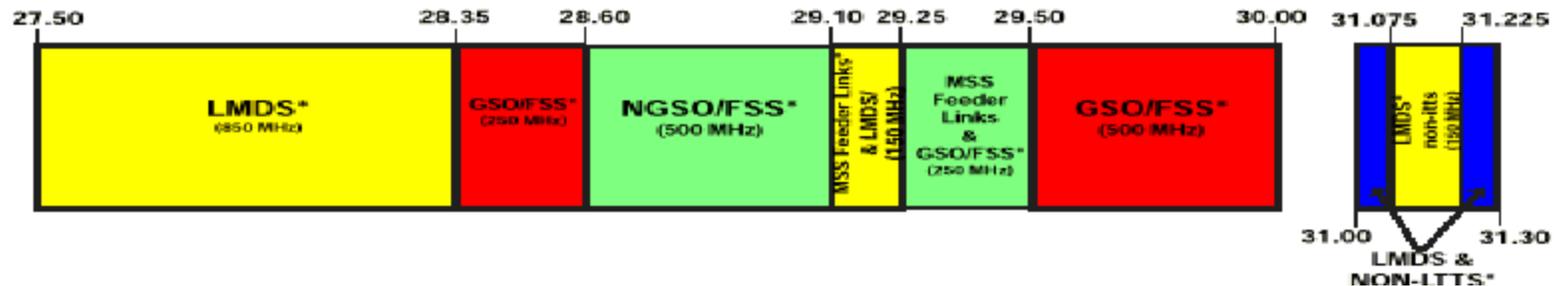
Distance learning, telemedicine, and telepresence are supported by next generation broadband networks. But these applications hit a bottleneck at most offices and almost all homes. Broadband wireless can eliminate this bottleneck.



The poor performance of many cellular and PCS-based web browsing and e-mail systems has given wireless Internet access a bad name.

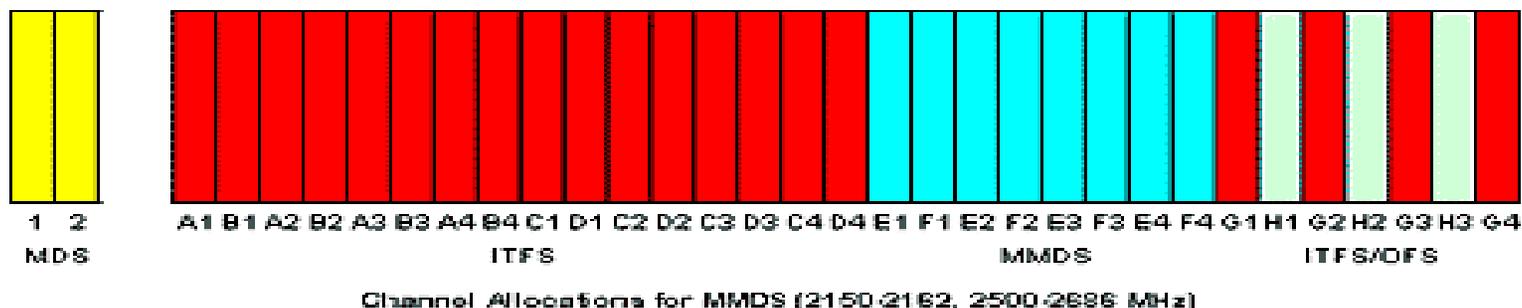
Nevertheless, there are a number of broadband spectral allocations that promise performance better than that of DSL and cable modems. These include both licensed and unlicensed spectrum.

LMDS



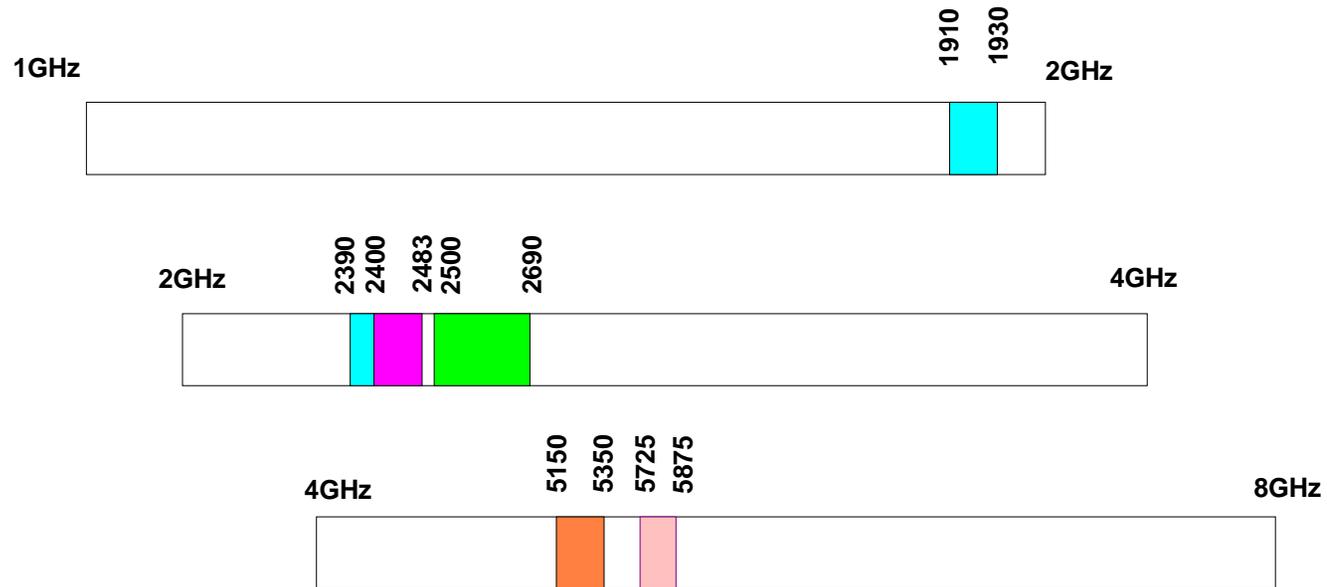
- An acronym for *Local Multipoint Distribution Service*
- A major new licensed spectrum allocation in the 28-31 GHz lower millimeter wave band
- An excellent vehicle for broadband wireless service

MMDS



- An acronym for *Multichannel Multipoint Distribution Service*
- MMDS channels come in 6 MHz chunks scattered over the range 2150 to 2686 MHz.
- Originally intended for “wireless cable” service, MMDS can now be used for data and Internet access.

Unlicensed Spectrum



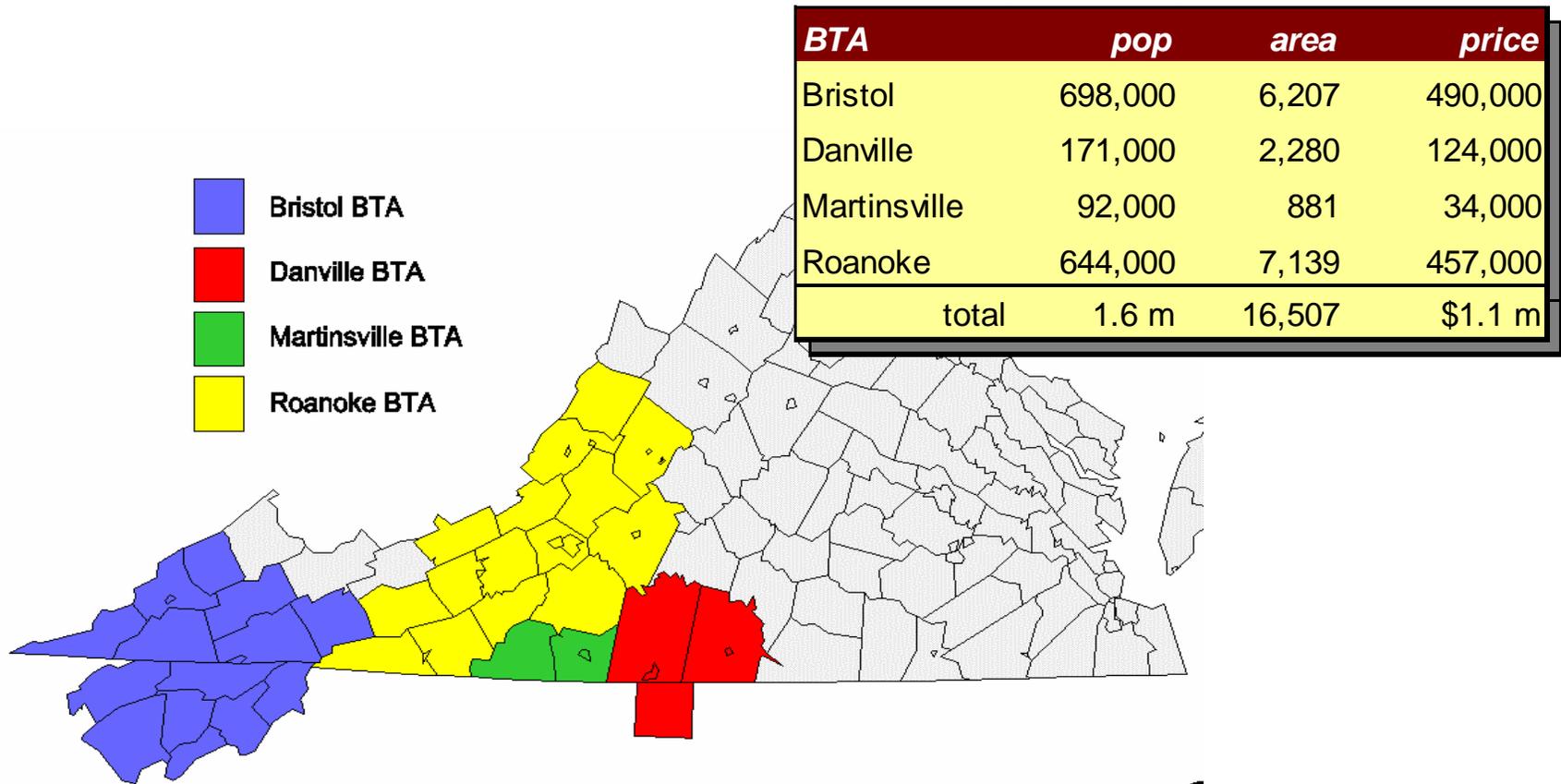
-  Unlicensed PCS
-  Industrial Scientific Medical (ISM)
-  Multichannel Multipoint Distribution Service (MMDS)
-  Unlicensed-National Information Infrastructure (U-NII)
-  U-NII and ISM

The U-NII Band

	Band 1	Band 2	Band 3
Frequency	5.15 to 5.25 GHz	5.25 to 5.35 GHz	5.725 to 5.825 GHz
Power (max)	200 mWatts (EIRP)	1 Watt (EIRP)	4 Watts (EIRP) '1
Intended Use	Indoor use only	Campus applications	Local access, 10 miles

- An acronym for *Unlicensed National Information Infrastructure*.
- U-NII devices will provide short-range, high speed wireless digital communications.
- Will support the creation of new wireless local area networks (LANs) and facilitate access to the information highway.

Our main interest is LMDS. The VA Tech Foundation bought four A licenses.



Our goal is to jumpstart broadband
Internet access for our region.



In our region, like most other suburban and rural areas:

- Fiber optic cable capacity is available in a few places as “fiber to the neighborhood.” It’s very expensive to go farther -- the “last mile” problem.
- TV cable does not reach most businesses.
- The existing telephone plant does not support DSL.

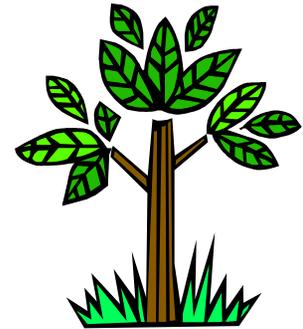
LMDS Offers

- A “Last Mile” communication solution
- License-protected operation in 29-31 GHz range
- A broadband wireless alternative to fiber, copper or coax
- No more bottlenecks between advanced communication networks and the home and office
- **More than twice the bandwidth** of the combined total of radio, broadcast television, and cell telephone
- Throughput of 10 Gbps (10,000 Mbps)



Advantageous for Rural Communities

- Quick to deploy, no digging roads
- Less expensive than fiber
- Fiber may never be available in many rural areas
- Can help communities “leapfrog” ahead in technology



However...

- The equipment is new and expensive and business cases don't make sense yet
- The industry needs more data and performance information especially on weather effects
- Line-of-sight is required for transmission (no obstacles); requires good planning

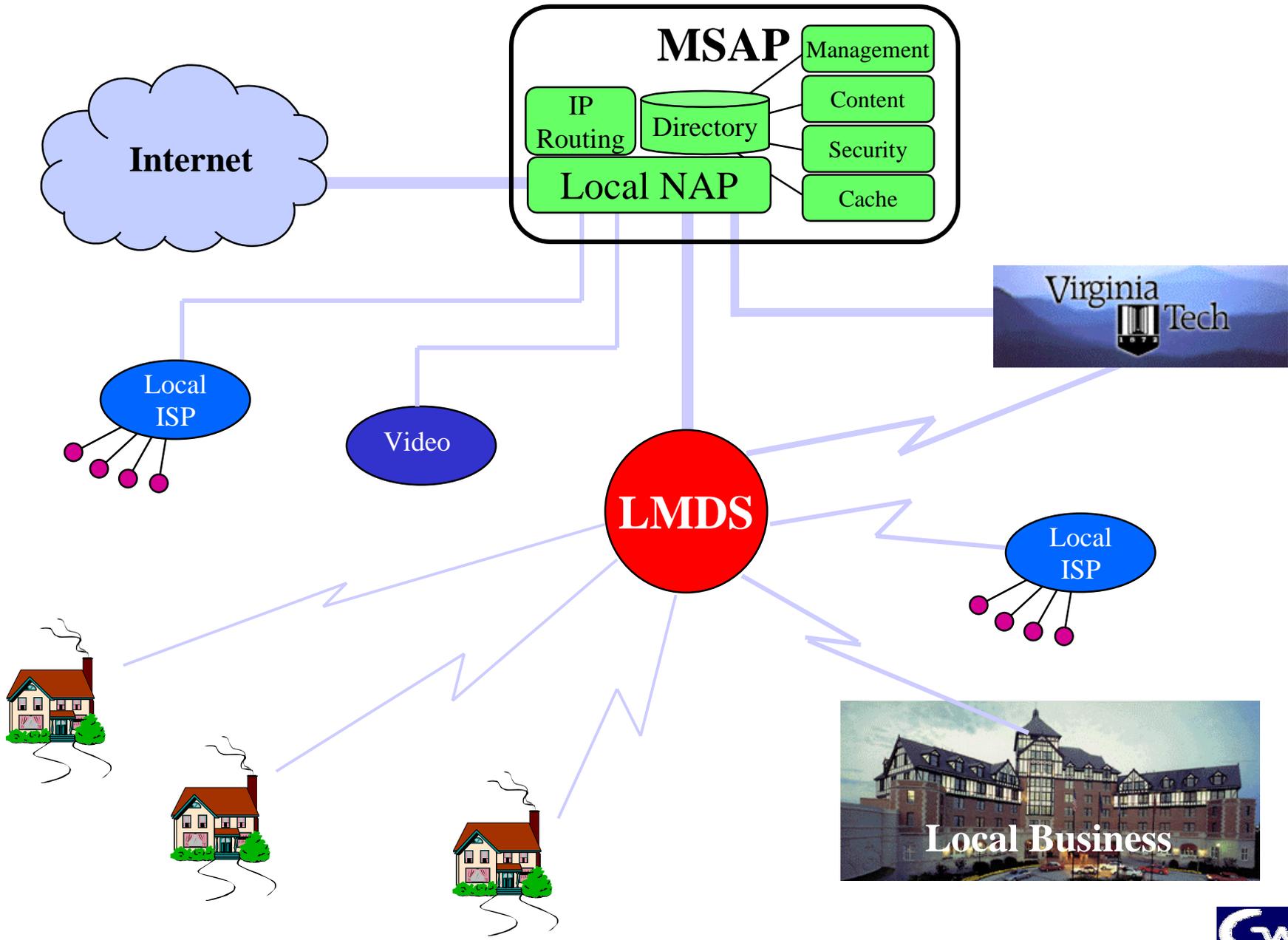
Our goal is to help Virginia communities develop Multi-Service Access Points (MSAPs), a kind of shopping mall for electronic services.

LMDS offers a broadband way to connect to the MSAP.

Once connected to the MSAP, LMDS customers can use any Internet Service Provider with a presence in their area.

We intend for LMDS to offer Southside and Southwest Virginians a new way to connect to the Internet that is faster and cheaper than anything else that is generally available. We will all benefit from the competition and from the new opportunities to attract information technology businesses.





Our Problem: Reaching Individuals and Small Business with Low-cost High-speed Connectivity

How do you provide high-speed (>5Mbps) commodity priced (\$50/month) service?

Current systems suffer from high cost per customer

- Point-to-Point systems are \$10,000+ per customer
- Point-to-Multipoint systems are \$5,000+ per customer
- Limited to high revenue customers

Nature of LMDS seems to limit reaching more customers

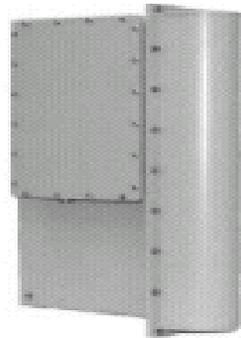
- Line of Site nature of LMDS limits coverage.
- Vegetation (trees) greatly reduce LMDS range
- LMDS signals will not penetrate buildings.

Initially, most LMDS radios seem to have been manufactured for high-end uses -- linking office building rooftops in urban settings. More recently, vendors have been addressing rural and household applications. CPE radio prices have dropped from ~\$30k per end to ~\$2.5k.

Low cost LMDS Equipment



WaveCom's
CPE 5000
Subscriber
XCVR \$2.5k



WaveCom's
TM 5000
Upconverter
\$6k



SMD 302 by
Microwave Dynamics



LMDS ODU by
KMW Inc.



Low cost (\$70) LMDS Antenna
by HD Communications Corp.



Modular and Planar LMDS
products by Telaxix
Communications

Low cost LMDS Equipment (contd.)



**BelStar's
Star 28
LMDS ODU**



**MRA28L by
Mentor Data Ltd.
Receiver Antenna**



**Dudley Lab's *HPTx*
Master Transmitter**



**Dudley Lab's *DC-xx*
Antenna/Downconverter**



**Dudley Lab's *LPT-x*
Repeater Transmitter**



**Dudley Lab's *SSTx/Rx*
Data Transmitter -
Receiver**

Our Approach

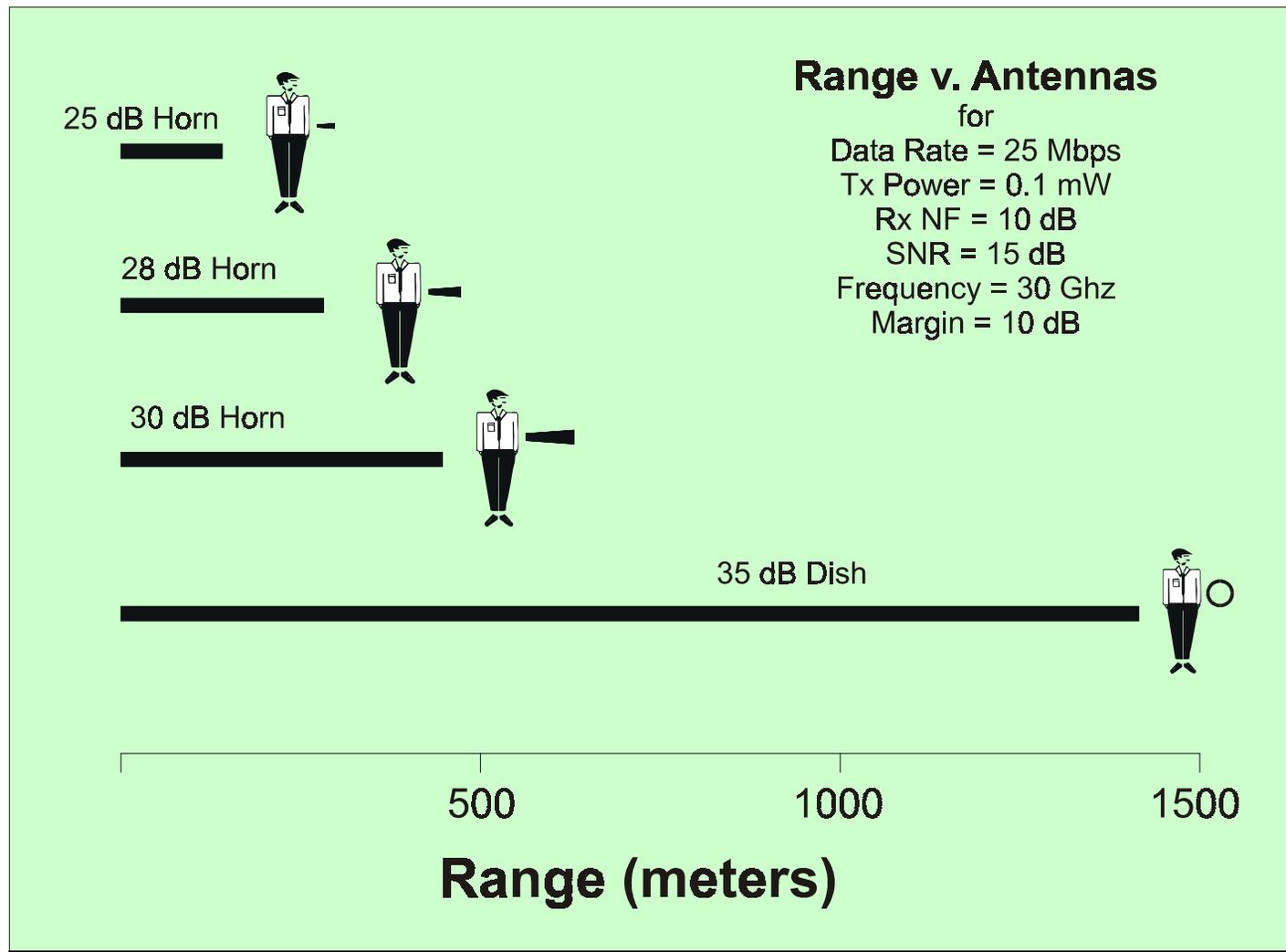
VERY low-cost short-range LMDS radios provide the network

- Low cost (\$200 - \$300) radios permit many short hops
- Go “under” the vegetation, not through it!
- Short range permits extensive frequency reuse

Design flexible options for “Last Hop” from network to user

- Combination of wired and wireless connections
 - LMDS and MMDS (2.5 GHz)
 - LMDS and U-NII
- To the user’s computer, the radio should look like an Ethernet port or a cable modem connection.

LMDS Transceiver/Repeater Size and Range



Short Range Applications

Wireless Cable Drop :

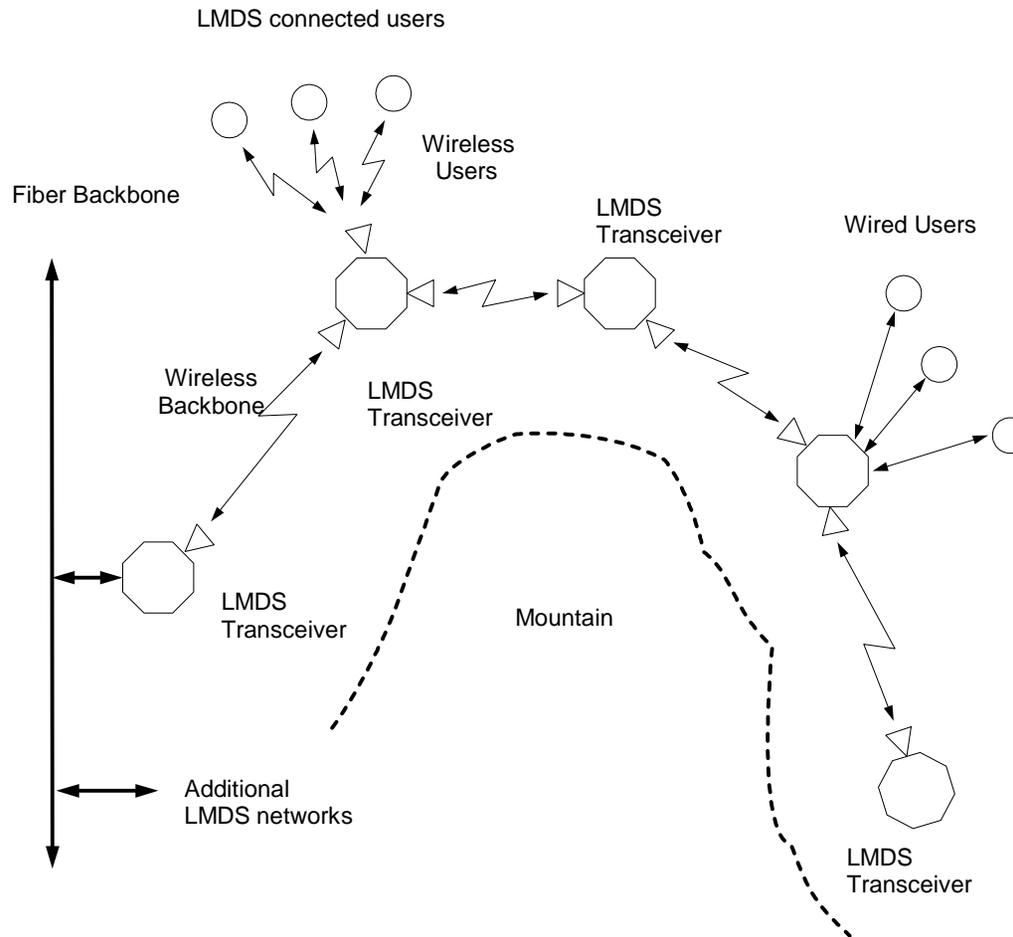
Wireless connections for wired systems

Repeaters and Extenders:

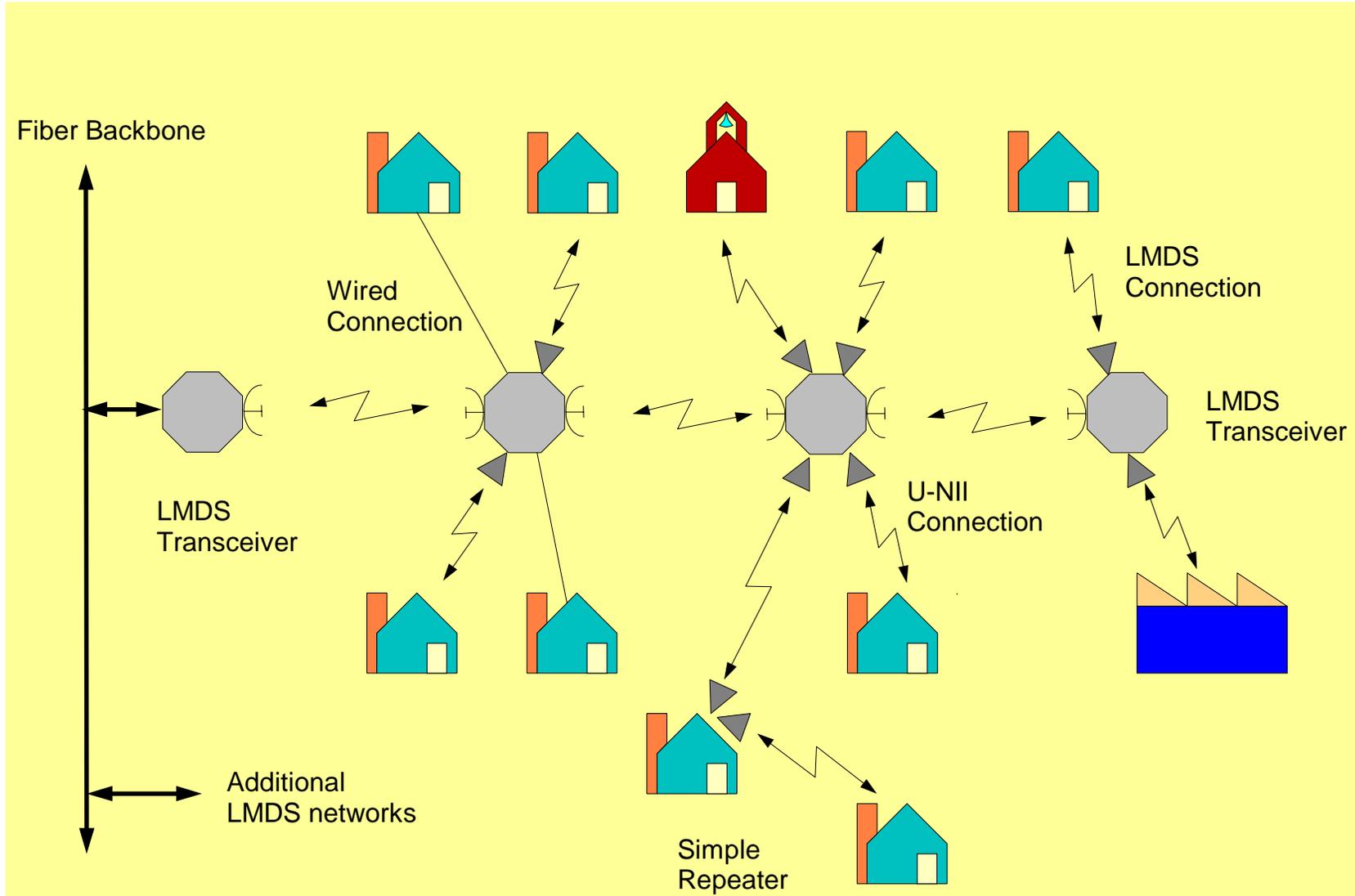
Fill shaded or block areas

LMDS Networking

LMDS Networking



A Proposed System



**Integrating LMDS backbone
with MMDS and U-NII:**

**Design LMDS transceivers
with first IF at MMDS or U-
NII and connect with users at
IF when appropriate.**

Low Cost LMDS Development

Test system: Under development

Microwave components: Inexpensive, off-the-shelf,
“Doppler” modules

Operating frequency: 24 GHz ISM band,
unlicensed Part 15 operation possible

28 GHz LMDS: Simple hardware migration

Radio Development

Radios compatible with a wide range of existing Customer Premise Equipment (CPE)

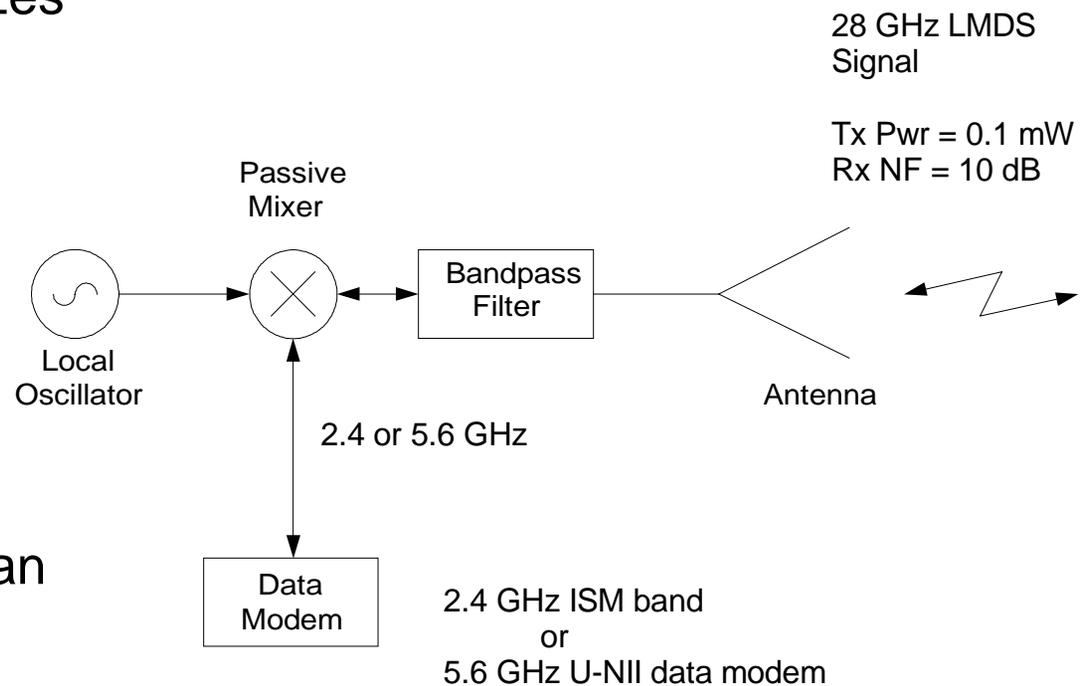
- Cable Modems
- Ethernet
- Custom CPE

Radios under development

- FSK Ethernet radio built around Doppler module technology
- Ultra low power converter to be used as a “front end” for existing 2.4 GHz ISM and 5.6 GHz u-NII equipment

Passive UP/Down Converter

- Passive mixer minimizes expensive Mmwave components



- Existing data radios can be used for LMDS

Our Test Radios

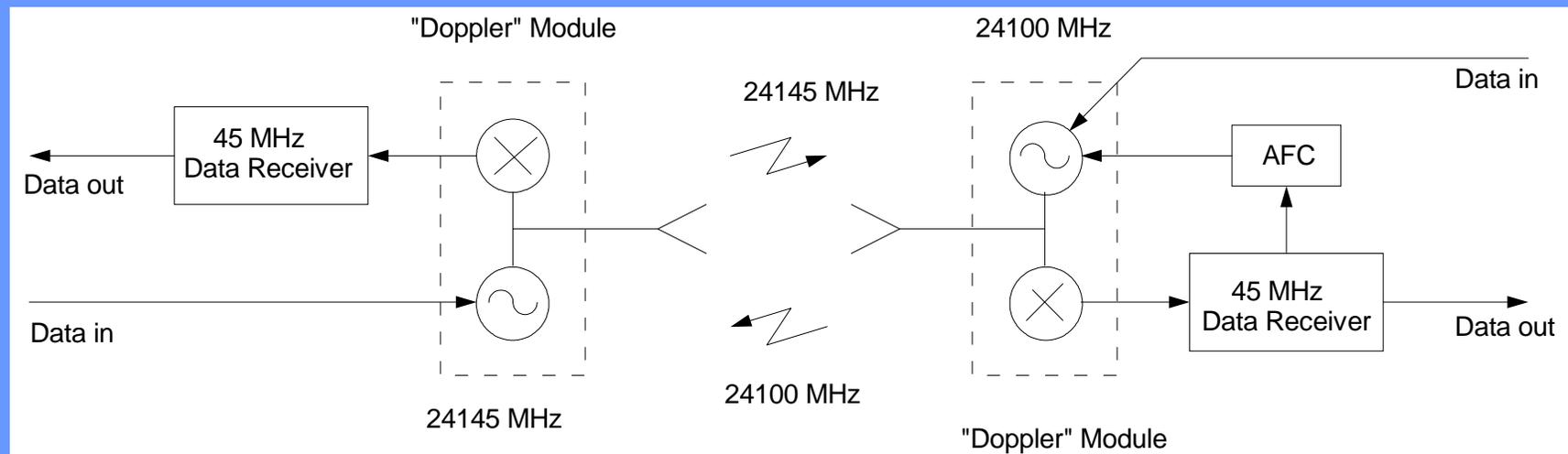
- **Simple radios are wireless Ethernet transceivers**

Transceivers used to form a LAN

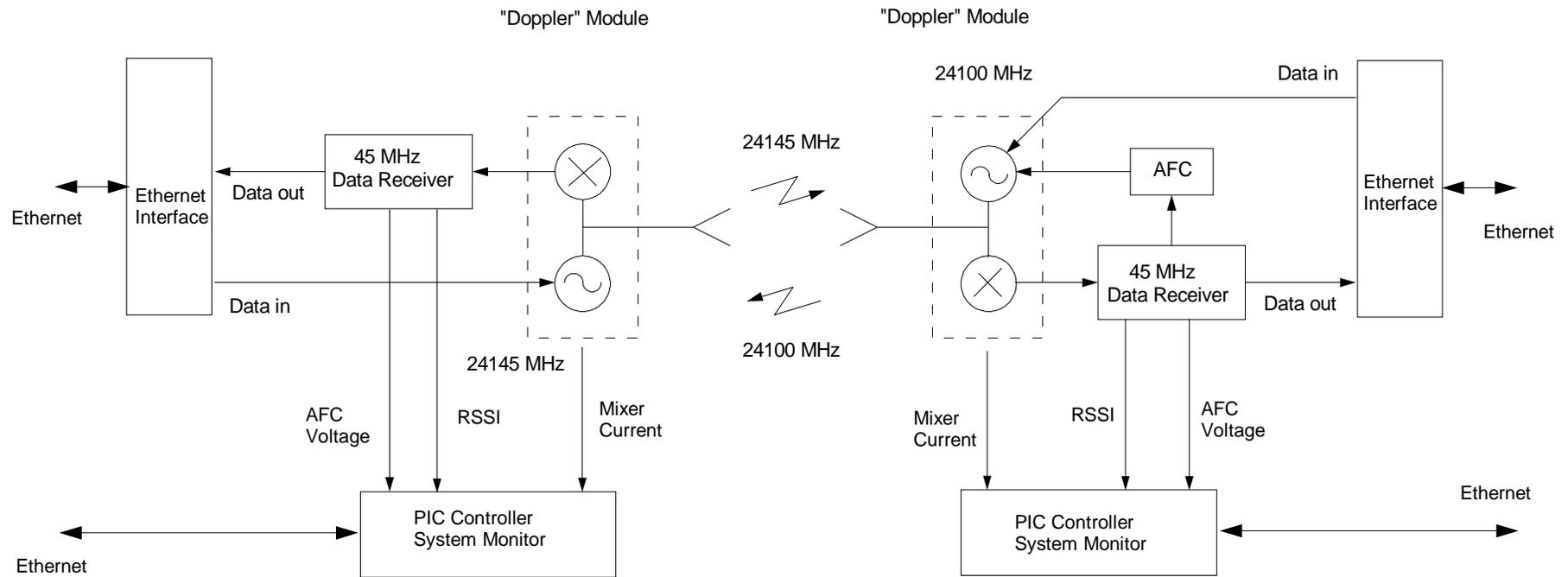
- **Each radio has a system monitor**

Monitor connection to Ethernet allows system health to be monitored from a remote location for higher reliability with simple radios

Low Cost LMDS Basic Block Diagram



Low Cost LMDS Full Block Diagram



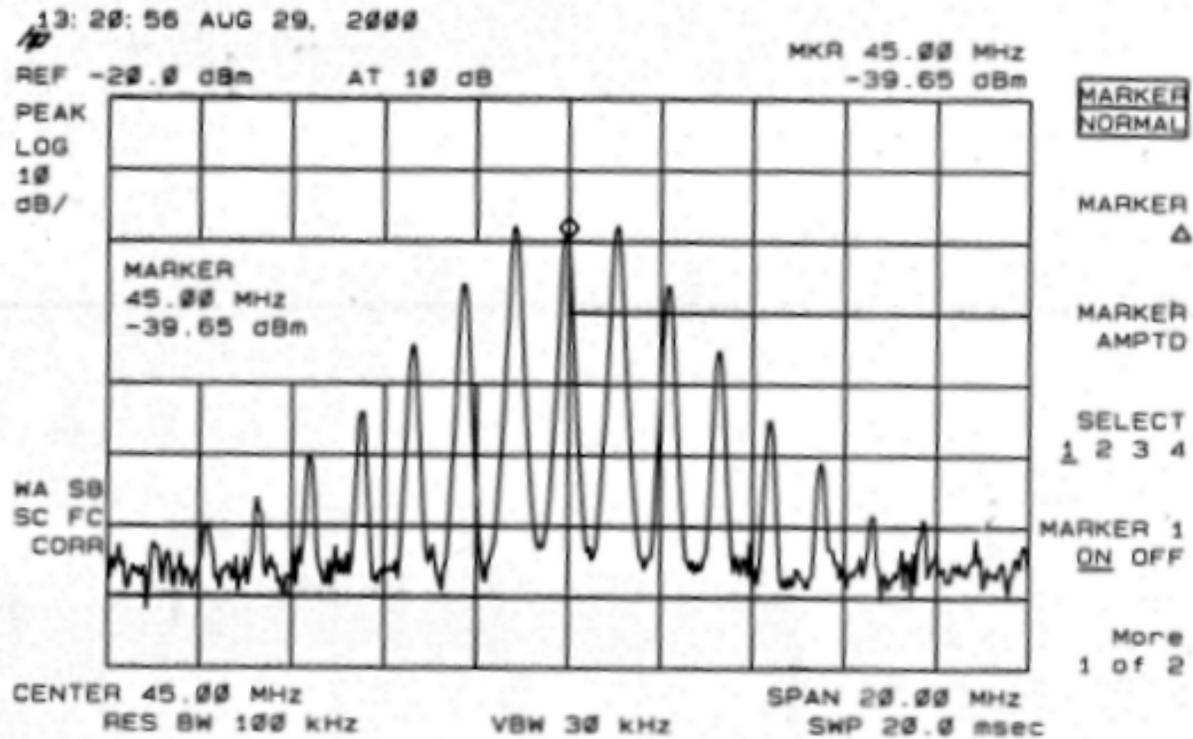
Modulation and Demodulation

Continuous-phase FSK is easily implemented since LO and RF frequencies are voltage controlled.

Non-coherent FM quadrature detection is available in inexpensive chips which contain almost all required IF stages. The detector generates a DC component which drives the automatic frequency control.

Transceiver Specifications

Carrier Frequency	24.15 GHz \pm 80 MHz
Bandwidth	4 MHz
Output Power	5 mW
Receiver NF	15 dB
IF Center Frequency	25 MHz
IF NF	8 dB
Data Rate	2 Mbps
Antenna Gain	20 dB
Range with 15 dB Fade Margin	750m



Output Spectrum @ 2 Mbps

High-speed Neighborhood LMDS Demonstration Project - McBryde Village



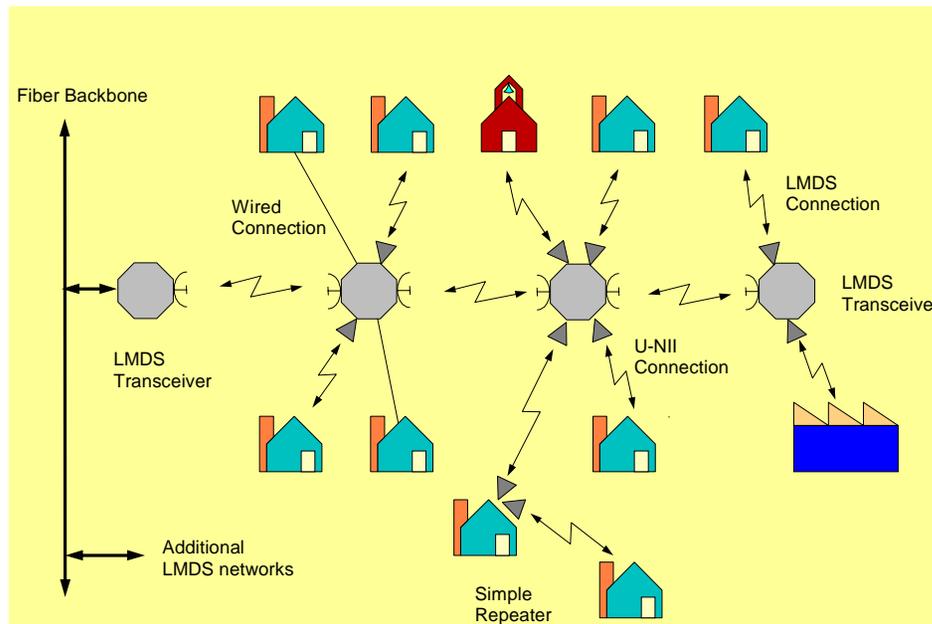
Adjacent to VA Tech campus

- Easy access to campus network
- View is from Whittemore Hall

VA Tech Electric services McBryde Village

- Access to power poles and electric power

In the coming year we anticipate building and fielding a full “ugly prototype” network.



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